MODEL 03 OHMS CONVERTER

DANA™

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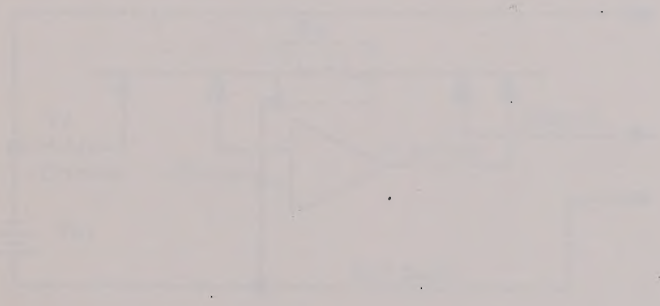


MODEL 03 OHMS CONVERTER

1.0 GENERAL DESCRIPTION

The Dana Model 03 Ohms Converter is a signal conditioning plug-in circuit board for use with Dana Series 5700 Digital Voltmeters (DVM's). The Ohms Converter allows resistance (in kilohms) to be measured with four leads. The board is located within and derives its supply voltages from the DVM.

2.0 SPECIFICATIONS

FULL SCALE RANGES

1.09999, 10.9999, 109.999, 1099.99, 10.999.9 kilohms

ACCURACY (6 Months)

±0.01% of reading and ±0.001% of f.s. except 1100 kilohm range;
±0.03% of reading and ±0.001% of f.s. on 1100 kilohm range

RESOLUTION

0.01 ohms

RESPONSE TIME

Step response
100 milliseconds

Response with range change
200 milliseconds

RANGE CONTROL

Automatic with manual override, selected by DVM front panel control

MEASURING TIME

DC measuring time plus 200 milliseconds for single range; DC measuring time plus 500 milliseconds worst case with automatic range

VOLTAGE ACROSS UNKNOWN

Approximately 10 volts at full scale proportionally less at less than full scale (open circuit voltage, 15v); maximum current limited to 10 milliamperes on 1.1K range.

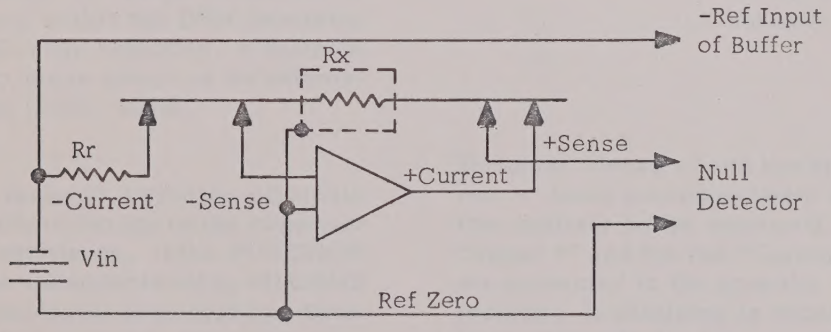


Figure 1. Ohms Converter

3.0 OPERATIONAL DESCRIPTION

The Ohms Converter is an operational amplifier shown simplified in Figure 1. The range resistor (R_r) determines the input current sink (-current) to the summing junction at the input of the amplifier (-sense). An equal amount of current is supplied to the summing junction by the output of the amplifier (+current) through the feedback resistor (R_x).

Because the currents into and out of the summing junction are equal, the summing junction is effectively at ground (zero volts). The output of the operational amplifier is equal to the I · R drop across R_x. This voltage is read by the DVM as a ratio of the unknown resistance to the range resistance or:

$$V_{in} \frac{R_x}{R_r}$$

where

R_x = Unknown resistor

R_r = Range resistor

V_{in} is applied internally to the reference input of the DVM so that the readout is completely determined by the ratio R_x/R_r with R_r determined by the range selection.

The appropriate range resistor is switched into the circuit by relays controlled by range signals within the DVM generated by a manual range selection, a decision by the auto range circuit or by external programming (5603, 5643).

Protective features virtually eliminate the possibility of damage to the converter by inadvertent misuse. If the FUNCTION switch of the voltmeter is not in KILOHMS position, the input is protected by a diode limiter and the output is protected by a replaceable fuse.

4.0 OPERATION

The Model 03 Converter uses a four-terminal method of measurement which allows the lead and contact resistances to be largely balanced out. The input cable to the instrument consists of five different leads; the Reference Input cable is not used in ohms measurement. It is important that the user understand the function of each lead and connect them properly. Alligator clips are installed on the leads. Two clips are larger than the other three. The input cable leads and the function of each are identified below:

LEAD FUNCTIONS

Current + (small red clip)	Delivers current (limited to 10 ma maximum at 1K)
Current - (small black clip)	Accepts current
Sense + (large red clip)	Senses voltage
Sense - (large black clip)	Senses voltage
Guard (small black clip)	Is connected to the floating shield (if any) of device being measured. Do not connect to unknown or ground.

The black "Sense -" and the black "Current -" leads are connected to one end of the resistor to be measured. The red "Sense +" and the red "Current +" leads are connected to the opposite end of the resistor. If shielding is necessary, the black "Guard" lead is connected to it (see Figure 2).

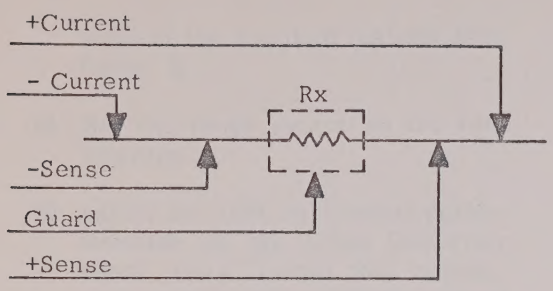


Figure 2. Measurement Connections

5.0 CALIBRATION

When shipped from the factory, the Model 03 is carefully calibrated well within specifications. Calibration adjustments in the field should not be required for at least six months (unless input cable is changed). Calibration should not be attempted unless accurate standards are available to verify the need for calibration and to make the calibration itself.

This procedure describes two techniques for the calibration of the Converter. Either procedure will provide quantitative information and data for its certification to the Manufacturers Specifications. It is recommended that the Standards Laboratory technique of calibration be used periodically since this will establish a "confidence level" over a long period of time.

5.1 Field Calibration

Equipment Required:

*1 - 10 Megohm Resistor, known or certified to better than ±0.01%.
*1 - 1 Megohm Resistor, known or certified to better than ±0.01%.
*1 - 100,000 ohm resistor, known or certified to better than ±0.01%.
*1 - 10,000 ohm resistor, known or certified to better than ±0.01%.
*1 - 1,000 ohm resistor, known or certified to better than ±0.01%.

(a) Turn on the DVM and allow at least one-half hour warm-up time.

(b) Select the 100K standard resistor and connect as shown in Figure 2.

Note: The black "Sense-" and the black "Current-" leads are connected to one end of the resistor and the red "Current +" and the red "Sense +" leads are connected to the other end of the resistor. It is usually necessary to shield the 100K resistor, in which case the guard would be connected to the shield.

(c) Set the MODE switch to the PERIODIC position.

(d) Set the FUNCTION switch to the OHMS position.

(e) Set the RANGE switch to the 110K position.

(f) Adjust the 100K calibration potentiometer on the Ohms Converter (third from bottom) to agree with the certified value of the standard resistor. (See Figure 3).

(g) Set the range switch to 10 Megohm position.

(h) Adjust the 10 Megohm calibration potentiometer (fifth Trimpot from bottom) to agree with the certified

*The temperature coefficient in parts per million per degree centigrade should be known. This is especially important where wide temperature gradients exist. Corrections in ppm/per degree centigrade should be applied where such conditions exist.

value of the standard resistor (see Figure 3).

(i) Set the range switch to the 100K position.

(j) Adjust the 100K calibration potentiometer on the Ohms Converter board, third Trimpot from bottom, to agree with the certified value of the standard resistor.

(k) Next install the 1 megohm standard resistor in place of the 100K standard, set the range switch to the 1 megohm calibration potentiometer on the Ohms Converter board (fourth trimpot from bottom) to agree with the certified value of the standard resistor.

(l) Next install the 10,000 ohm standard resistor in place of the 1 megohm standard, set the range switch to the 10K position, and adjust the 10K calibration potentiometer on the Ohms Converter board (second trimpot from bottom) to agree with the certified value of the standard resistor.

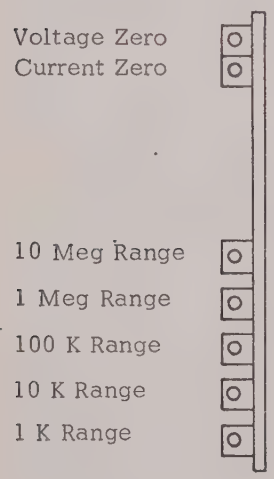


Figure 3. Ohms Converter Adjustments

(m) Next install the 1,000 ohm standard resistor in place of the 10,000 ohm standard, set the range switch to the 1K position, and adjust the 1K calibration potentiometer on the Ohms Converter board (bottom trimpot) to agree with the certified value of the standard resistor.

Notes: Since there is some interaction between the various calibration adjustments, it is important that the ranges be calibrated in the order shown. Do not attempt to adjust either the "Voltage Zero" or "Current Zero" trimpots in the field. These adjustments must be made with a Null Galvanometer and are best done in the Standards Laboratory.

5.2 Standards Lab Calibration Procedure

The technique for Standards Laboratory calibration of the Dana 03 Ohms to DC Converter is that used by the factory. It is designed to provide the user with the highest accuracy possible using Laboratory standards.

Equipment Required:

1 - 10,000,000.0 ohm standard resistor, or certified to $\pm$0.005% or better with T/C of 10 ppm or less. E.S.I. SRI series.

1 - 1,000,000.0 ohm standard resistor, or certified to $\pm$0.005% or better with T/C of 10 ppm or less. L & N 4020 NBS series.

1 - 100,000.0 ohm standard resistor, known or certified to ±0.002% or better with T/C of 10 ppm or less. L & N 4020 NBS series.

1 - 10,000.0 ohm standard resistor, known or certified to ±0.002% or better with T/C of 10 ppm or less. L & N 4020 NBS series.

1 - 1,000.0 ohm standard resistor, known or certified to ±0.005% or better with T/C of 10 ppm or less. L & N 4020 NBS series.

1 - Guarded DC electronic null detector. L & N Model 9834 or equivalent.

In standards laboratories equipped for close temperature control, it is recommended that the DVM be "temperature soaked" in an operating condition for at least two hours prior to calibration.

(a) Connect the null detector as shown in Figure 4. ("Guard" is galvo common, red "Sense +" lead is galvo + input). Set the DVM on the 1,000K range.

(b) Short the red "Sense +", red "Current +", and black "Sense -" leads together. Connect the "Current-" and the Guard to galvo common. The "Ext Ref" lead is not used.

(c) Zero or null the DVM as indicated on the null detector by adjusting the Voltage Zero (top trimpot) on the Ohms to DC Converter. This zero or null should be less than 20 microvolts.

(d) Next, connect the 1 megohm standard resistor as shown in Figure 5. The "Ext Ref" lead is not used.

(e) Zero or null the DVM as indicated on the Null Detector by adjusting the Current Zero (second from the top) on the Ohms to DC Converter. This zero or null be adjusted to approximately 25 microvolts or less (noise level of this approximate level is normal).

(f) Use the 100K ohm standard resistor and set the controls as follows:

MODE switch to the PERIODIC position.

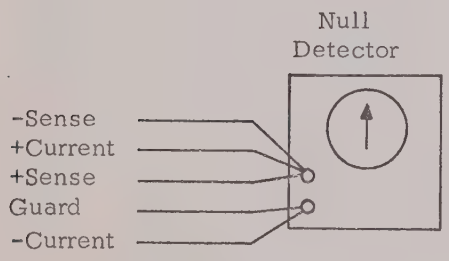


Figure 4. Voltage Zero Adjustment

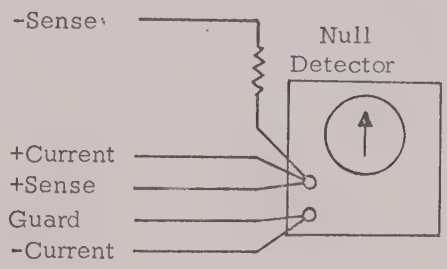


Figure 5. Current Zero Adjustment

FUNCTION switch to the OHMS position.
RANGE switch to the 110K position.
Threshold potentiometer to full clockwise position.
Connect the black "Sense -" lead to one potential terminal on the NBS standard resistor.
Connect the black "Current -" lead to the adjacent current terminal on the NBS standard resistor.
Connect the red "Current +" lead to the other current terminal on the NBS standard resistor.
It is usually necessary to place the test resistor in a floating shield in which case, the Guard will be connected to the shield.
The "Ext Ref" lead is not used.

(g) Adjust the 100K calibration potentiometer on the Ohms to DC Converter (third from bottom) to agree with the certified value of the standard resistor.

(h) Replace the 100K standard resistor with the 10 megohm standard, set the range switch to the 11,000K position, and adjust the 10 megohm calibration potentiometer on the Ohms to DC Converter (fifth from bottom) to agree with the certified value of the standard resistor.

(i) Replace the 10 megohm standard resistor with the 1 megohm standard, set the RANGE switch to the 1.00K position, and adjust the 1 megohm calibration potentiometer on the Ohms to DC Converter (fourth from bottom) to agree with the certified value of the standard resistor.

(j) Replace the 1 megohm standard resistor with the 10,000 ohm standard, set the RANGE switch to the 11K position, and adjust the 10K calibration potentiometer on the Ohms to DC Converter (second from bottom) to agree with the certified value of the standard resistor.

(k) Replace the 10,000 ohm standard resistor with the 1,000 ohm standard, set the RANGE switch to 1.1K calibration potentiometer on the Ohms to DC Converter (bottom) to agree with the certified value of the standard resistor.

(l) This completes the calibration. If desired and required, intermediate values of resistances by means of series/parallel combinations of standard resistors may be measured and recorded.

NOTE: Since there is some interaction between the various calibration adjustments, it is important that the ranges be calibrated in the order shown.

6 0 TROUBLESHOOTING

Functionally check the operation of the DC Preamplifier by measuring known voltages on each range. Refer to list below for aid in isolating malfunctions.

1. Output Random Numbers

   (a) Check regulated power supplies (+18 and -10)

   (b) Check chopper drive (Q22 and Q25)

   (c) Check De-modulation Phasing (Q14 and Q18)(Figure 1

2. Abnormal Reading on All Ranges

   (a) Place DVM in HOLD position and apply approximately 15 volts to input. Monitor junction of C6 and chopper arm for a symmetrical chopper wave form (Figure 2)

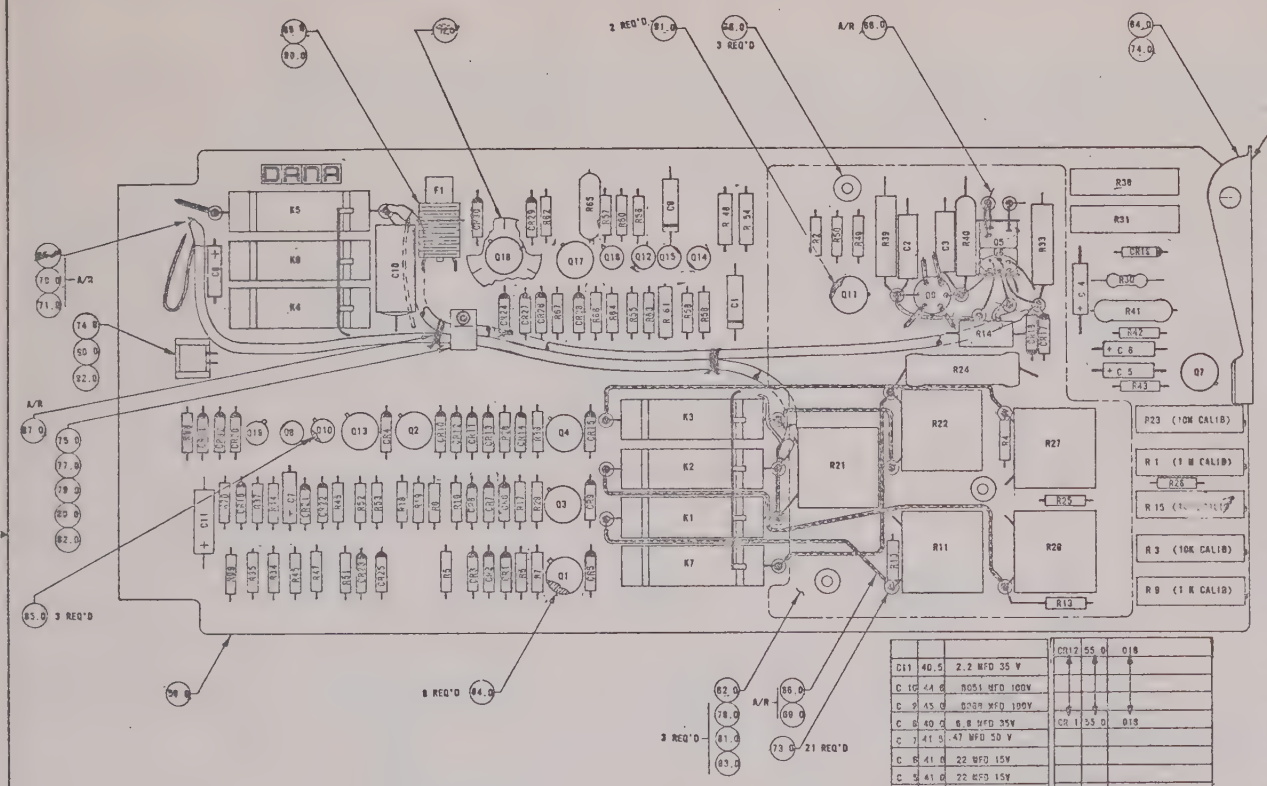
   (b) Check transistor Q1, Q23, and Q24

3. Abnormal Reading on 100mv Range

   (a) Check K2 and associated driver circuitry

4. Abnormal Readings on 1000mv Range

   (a) Check K1 and associated driver circuitry



Q18	47.0	Q12												R70	4.0	10 M			
Q15	51.0	2N3565												R23	8.0	12 k			
Q14	51.0	2N3565												R73	17.0	5.1 k			
Q13	48.0	Q14												R 32					
Q12	51.0	2N3565												R 31	29.0	100K POT.			
Q11	50.0	Q16												R 30	25.0	15 k 1%			
Q10	53.0	Q68												R 29	7.0	120K			
Q9	50.0	Q18												R 28	13.0	24K			
Q8	48.1	2N3645												R 27	35.0	1K 01%			
Q7	48.0	Q69												R 26	4.0	10M			
Q6	46.0	Q15												R 25	19.0	510K			
Q5	52.0	2N1304												R 24	39.0	9.888M .1%			
Q4	48.5	Q14												R 22	37.0	20K POT			
Q3	49.0	Q14												R 22	37.0	10K 01%			
Q2	46.0	Q14												R 21	34.0	80K 01%			
Q1	47.0	Q14												R 20	33.0	10.1K 01%			
														R 18	21.0	7.5K			
F1	85.0	0.1 AMP												R 17	21.0	7.5K			
CR32	56.0	1/4M 2 4 AZ10												R 16	23.6	8.66			
CR31	55.0	Q18												R 15	35.0	100K POT			
CR30	54.0	SD4												R 14	33.0	1K 01%			
CR29	54.0	SD4												R 13	4.0	10M			
CR28	55.0	Q18												R 12					
CR27	55.0	Q18												R 11	35.0	1K 01%			
CR26	55.0	Q18												R 10	3.0	13			
CR25	55.0	Q18												R 9	38.0	100K POT			
CR24	57.0	1N931A												R 8	7.0	120K			
CR23	53.0	Q18												R 7	7.0	120K			
CR22	53.0	1N2 4AZ10												R 6	21.0	7.5K			
CR21	55.0	Q18												R 5	23.0	8.25			
CR20	55.0	Q18												R 4	4.0	10M			
CR19	57.0	1N931A												R 3	33.0	100K POT			
CR18	55.0	Q18												R 2	32.0	499Ω			
CR17	54.8	SD 4												R 1	30.0	100K POT.			
CR16	54.8	SD 4																	
CR15	55.0	Q18												Q18	53.0	Q18			
CR14	55.0	Q18												Q 19	49.0	Q14			
CR13	55.0	Q13												Q 17	51.0	Q14			

C11	40.5	2.2 MFD 35 V												CR12	55.0	Q18			
C 10	44.0	0051 MFD 100V																	
C 9	45.0	0088 MFD 100V												CR 11	55.0	Q18			
C 8	40.0	6.8 MFD 35V																	
C 7	41.5	47 MFD 50 V																	
C 6	41.0	22 MFD 15V																	
C 5	41.0	22 MFD 15V																	
C 4	40.0	6.8 MFD 35V												K 7	58.0	310013			
C 3	43.0	470 pf																	
C 2	43.0	470 pf																	
C 1	43.0	0088 MFD 100V												K 1	58.0	310013			
REF DES	B/M ITEM	DESCRIPTION												REF DES	B/M ITEM	DESCRIPTION			

CROSS REFERENCE CHART			
ITEM NO	PART NO.	ITEM NO.	PART NO
59.0	438789	78.0	810159
60.0	459121	79.0	812044
62.0	451136	80.0	815051
65.0	510032	79.0	817044
66.0	500394	80.0	813317
67.0	503[illegible]	81.0	817079
68.0	503037	82.0	817102
69.0	521076	83.0	817103
70.0	507446	84.0	821051
71.0	524010	84.0	821007
72.0	4[illegible]5	89.0	820043
73.0	500030	90.0	820054
74.0	5 [illegible]19	91.0	820092
75.0	510050	92.0	820113

4. ASSEMBLY PROCEDURES AND PROCESSES TO CONFORM WITH DANA WORKMANSHIP STANDARDS

3. SCHEMATIC REFERENCE: 430420

2. AFFIX CARD IDENTIFICATION LABEL (PART OF 450187) TO HANDLE IN LOCATION SHOWN, DURING FINAL ASSEMBLY

F1. ALL RESISTORS ¼ W. 5% CARBON

NOTES: UNLESS OTHERWISE SPECIFIED

QTY REQD	SYM	ITEM NO.	GOVT OR VENDOR NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION

LIST OF MATERIAL OR PARTS LIST

NEXT ASSY	USED ON	NA	FA
APPLICATION		QTY REQD	

MATERIAL: SEE L/M

APPLIED FINISH

HEAT TREATMENT

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS: .X ± .020, .XX ± .010, .XXX ± .010
ANGLES ± 0° 30'
FORMED ANGLES ± 1.0°
CONCENTRICITY BETWEEN ANY TWO DIAMETERS SHALL NOT EXCEED .010 TIR.
INTERPRET DRAWING IN ACCORDANCE WITH STANDARDS MIL-D-1000 AND MIL-D-70327

CONTRACT NO.

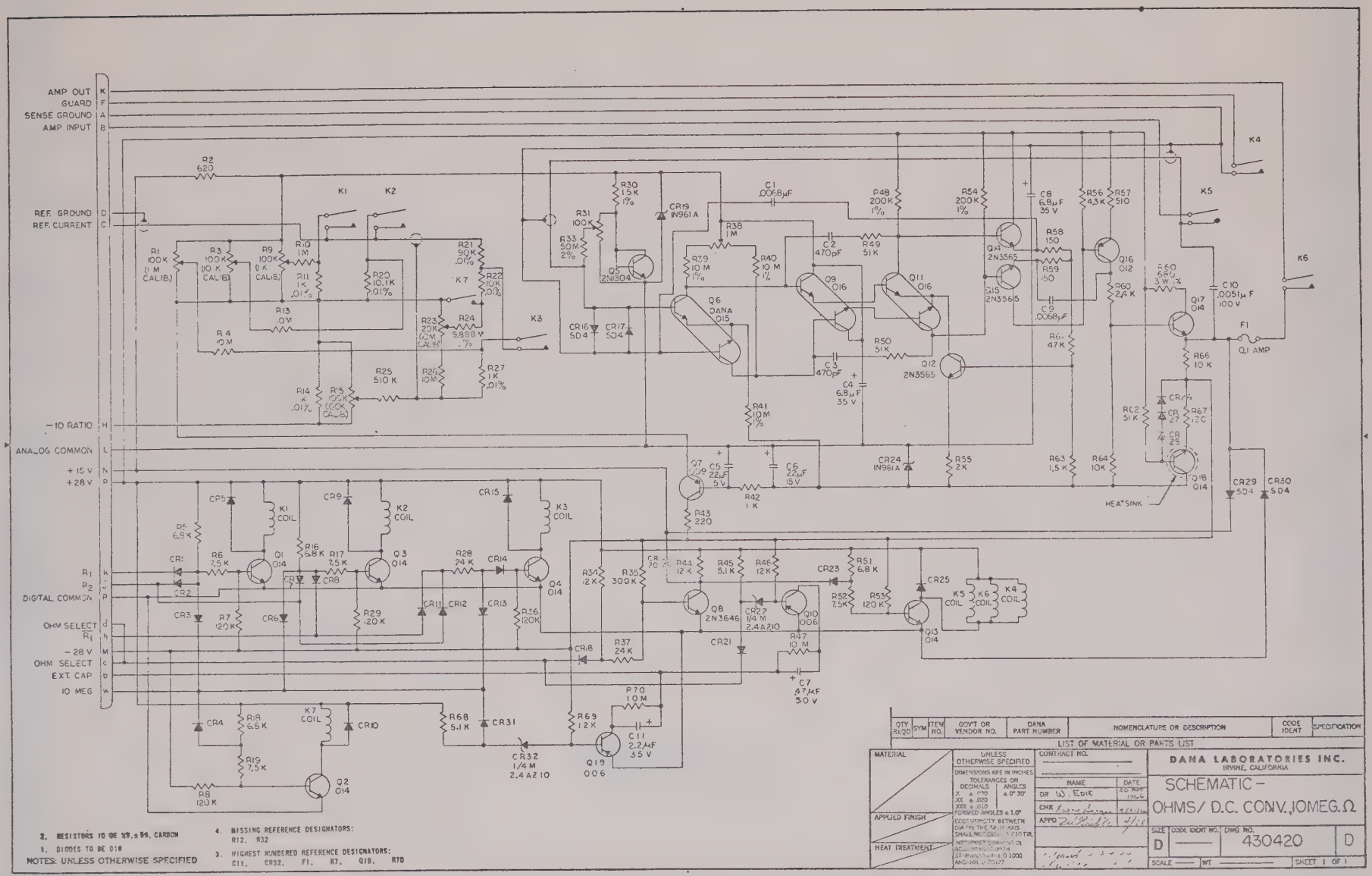
	NAME	DATE
DR	D. WOOD	INITIAL
CHK	[illegible]	[illegible]
APPD	[illegible]	10/12

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

P.C.BOARD ASS'Y
OHMS / D.C. CONV. 10 MEG.Ω

SIZE	CODE IDENT NO.	DWG NO.
D	21793	402500

SCALE 2:1 | WT | SHEET 1 OF 1



2. RESISTORS TO BE 1/2, ± 5%, CARBON
1. DIODES TO BE 018
NOTES: UNLESS OTHERWISE SPECIFIED

4. MISSING REFERENCE DESIGNATORS: R12, R32
3. HIGHEST NUMBERED REFERENCE DESIGNATORS: C11, CR32, F1, R7, Q19, R70

QTY REQD	SYM	ITEM NO.	GOVT OR VENDOR NO.	DANA PART NUMBER	NOMENCLATURE OR DESCRIPTION	CODE IDENT	SPECIFICATION

LIST OF MATERIAL OR PARTS LIST

MATERIAL
APPLIED FINISH
HEAT TREATMENT

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON DECIMALS: X ± .010, XX ± .020, XXX ± .010; ANGLES ± 0° 30'
FORMED ANGLES ± 1.0°
CONTRACT NO.

	NAME	DATE
DR	W. Edie	10-30-64
CHK		11-1-64
APPD		11-1-64

DANA LABORATORIES INC.
IRVINE, CALIFORNIA

SCHEMATIC – OHMS/ D.C. CONV., 10MEG. Ω

SIZE	CODE IDENT NO.	DWG NO.	
D	—	430420	D

SCALE — WT — SHEET 1 OF 1

Warranty

It is the practice of Dana Laboratories, Incorporated, to manufacture only products of a quality that will merit customer satisfaction. The company recognizes that customer satisfaction is achieved, not only by delivering products meeting advertised performance specifications and having a high level of reliability, but also by honestly and efficiently fulfilling their warranty obligations as set forth below.

Dana Laboratories, Inc., agrees to correct, either by repair or replacement, any defect of material or workmanship in Dana-manufactured units or components which develop within one year after delivery of the equipment to the original purchaser — provided that the equipment has been subjected only to normal and proper use.

In the event of failure of any component delivered with Dana equipment, but not manufactured by Dana Laboratories, assistance will be given the customer in obtaining, from the original manufacturer, reasonable adjustment under that manufacturer's warranty.

Any item claimed to be defective during the warranty period must be returned to Dana Laboratories, Inc., with transportation charges prepaid. The item will be repaired and returned to the purchaser with return transportation prepaid by Dana unless, of course, the item is found not to be defective or found to be damaged by misuse — in which case it will be returned to the purchaser with repair and transportation billed collect.

DANA

DANA™

MP MASTER
MA31087